

**THE INSECTS ASSOCIATED WITH GALLS FORMED BY
TRICHILOGASTER ACACIAELONGIFOLIAE (FROGGATT)
(HYMENOPTERA: PTEROMALIDAE) ON *ACACIA* SPECIES IN
TASMANIA**

R. BASHFORD

Forestry Tasmania, GPO Box 207, Hobart, Tas 7001

E-mail: dick.bashford@forestrytas.com.au

Abstract

Galls produced by *Trichilogaster acaciaelongifoliae* (Froggatt) were collected over several years from several phyllodinous species of *Acacia*, mainly *A. sophorae* and *A. stricta*, and the insects reared from them. The number of gall-forming adults and parasitoids reared from individual galls is compared with the size of the galls. The effect of galling on host plant health is commented on in relation to planting of these *Acacia* species in community or government funded projects. Twenty-one insect species were reared from galls formed by *Trichilogaster acaciaelongifoliae* on *Acacia* species in Tasmania.

Introduction

One of the 'classic' papers in Australian entomological literature is that of Noble (1940), in which he examined the biology of the pteromalid *Trichilogaster acaciaelongifoliae* (Froggatt) and showed that this species was responsible for gall formation on a number of phyllodinous wattle species in the Sydney area, New South Wales. In recent times some of those wattle species have been introduced to South Africa, in particular *Acacia longifolia* (Andr.) Willd., which has become an invasive weed (Boucher and Stirton 1978). A program of biological control of *A. longifolia* has commenced with the release (Dennill 1987) of *T. acaciaelongifoliae*, the aim being to reduce seed production and vegetative growth (Dennill 1985).

In Tasmania, phyllodinous wattles are widely planted in coastal reserves and town park areas as they are fast growing and require little maintenance once established. The presence of large numbers of galls results in the decline in health of wattles in planting projects. The visual result is unsightly and replanting is required after several years. It is recommended that community funded revegetation projects plant *Acacia* species less susceptible to galling by *T. acaciaelongifoliae*.

Methods

Galls were collected from three coastal amenity plantings of *Acacia sophorae* (Labill.) R. Br. ex Ait. (Boobyalla or Coast Wattle) and *A. stricta* (Andr.) Willd. (Hop Wattle) on an opportunistic basis. Regular collections were made from two large, heavily galled *A. sophorae* shrubs planted in 1990, spaced 500 m apart, in a fire rehabilitation planting at Bell Bay in northern Tasmania. Collections were made every two weeks during the life of the galls, from late October 1999 to the end of May 2001 and some dead galls were collected to identify some inquiline species. Voucher specimens are deposited in the Tasmanian Forest Insect Collection, Hobart.

Mass groups of galls were placed in 19 cm diameter glass petri dishes and emerging insects removed weekly. Individual galls were held in plastic food containers with perforated lids to prevent build up of condensation. All galls were weighed within 6 hours of collection, either in mass groups or individually, after being transported in sealed paper bags. All galls were held in a controlled temperature room at 18°C. Humidity in the glass dishes was 70% RH when containing green galls, declining to 40% RH when containing old dry brown galls.

Galls from two northern and one southern site were divided into three size classes (<20 mm, 20-30 mm and >30 mm diameter). Volumes and weights of the gall groups were calculated and the galls retained for insect emergence. Analysis of variance was used to determine differences between emergence and gall size and sites and gall size at the 95% confidence level.

Table 1. The insects reared from galls formed by *T. acaciaelongifoliae* on *Acacia sophorae* in Tasmania.

Insect species	Family	Number of specimens
Hymenoptera		
<i>Trichilogaster acaciaelongifoliae</i> (Froggatt)	Pteromalidae	1865
<i>Poecilocryptus nigromaculatus</i> Cameron	Ichneumonidae	118
<i>Eriostethus</i> sp.	Braconidae	11
<i>Megastigmus ?darlingi</i>	Torymidae	45
<i>Megastigmus</i> sp.	Torymidae	19
<i>Eurytoma gahani</i> Noble	Eurytomidae	105
<i>Glabridorsum stokesii</i> (Cameron)	Ichneumonidae	1
<i>Chromeurytoma noblei</i> (Girault)	Pteromalidae	395
<i>Ormyromorpha</i> sp.	Pteromalidae	1
<i>Coelocyba nigrocincta</i> Ashmead	Pteromalidae	1
<i>Sierola</i> sp.	Bethylidae	1
Coleoptera		
<i>Araecerus palmaris</i> (Pascoe)	Anthribidae	1240
<i>Eleale</i> sp.	Cleridae	27
Lepidoptera		
<i>Polysoma eumetalla</i> (Meyrick)	Gracillariidae	167
<i>Erechthias mustacinella</i> (Walker)	Tineidae	108
<i>Stathmopoda cephalaea</i> Meyrick	Oecophoridae	14
<i>Holocola (Eucosma) triangulana</i> Meyrick	Tortricidae	89
<i>Macrobathra</i> sp.	Cosmopterigidae	22
<i>Gauna aegusalis</i> (Walker)	Pyralidae	5
<i>Opogona comptella</i> (Walker)	Tineidae	1
Hemiptera		
<i>Nipaecoccus ericicola</i> (Maskell)	Pseudococcidae	

Results

A list of the insects associated with galls collected from *Acacia sophorae* bushes at coastal amenity plantings on the east and north coasts of Tasmania is presented in Table 1. Emergence patterns over a two-year period for all species emerging from *T. acaciaelongifoliae* galls are shown in Fig. 1.

Month of emergence	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Hymenoptera																							
<i>T. acaciaelongifoliae</i>																							
<i>Chromeyrtoma noblei</i>																							
<i>Eurytoma gahani</i>																							
<i>Ormyromorpha</i> sp.																							
<i>Coelocyba nigrocincta</i>																							
<i>Sierola</i> sp.																							
<i>Megastigmus</i> ? <i>darlingi</i>																							
<i>Megastigmus</i> sp.																							
<i>P. nigromaculatus</i>																							
<i>Eriostethus</i> sp.																							
<i>Glabridorsum stokesii</i>																							
Coleoptera																							
<i>Araecerus palmaris</i>																							
<i>Eleale</i> sp.																							
Lepidoptera																							
<i>Polysoma eumetalla</i>																							
<i>Erechthias mystacinella</i>																							
<i>Stathmopoda cephalaea</i>																							
<i>Holocola triangulara</i>																							
<i>Macrobathra</i> sp.																							
<i>Gauna aegusalis</i>																							
<i>Opogona comptella</i>																							

Fig. 1. Emergence periods of insect species recorded from *Trichilogaster acaciaelongifoliae* galling on *Acacia sophorae* in Tasmania.

Notes on insect species utilising *T. acaciaelongifoliae* galls

The primary gall former, *T. acaciaelongifoliae*, emerged from late November to early April at northern Tasmanian sites and between late December and early March at southern Tasmanian sites (Fig. 1). Sex ratio was 0.48:1.0 (606 males, 1259 females).

The ichneumonid *Glabridorsum stokesii* is a generalist parasitoid of Lepidoptera species. The other ichneumonid, *Poecilocryptus nigromaculatus*, was a common species at all sites (56 males, 62 females). This species was found to prey indiscriminately on the primary gall former and associated parasitoids in galls on *Melaleuca* produced by fergusoninid flies (Goolsby *et al.* 2001). It is surprising that this species was not recorded from *Uromycladium* galls at the same sites (Bashford 2002).

The chalcid wasps are all parasitoids or predators of the primary gall former and, in some cases, hyperparasitoids. *Eurytoma gahani* and *Chromeytoma noblei* were common emergents from galls at most sites. *C. noblei* emerged in greater numbers but from fewer galls than *E. gahani*. *E. gahani* and *Coelocyba nigrocincta* larvae appear to feed phytophagously within the cell occupied by the developing gall former larva until the final instar. On attaining this stage of development the gall former larva is devoured (Noble 1940). It may be some months before the larva pupates in order to synchronize with new gall formation. (Noble 1939a).

Two species of *Megastigmus* emerged from the galls, one with a long ovipositor, *Megastigmus ?darlingi* and one with a short ovipositor, *Megastigmus* sp. Some species of *Megastigmus*, for example *M. acaciae*, are internal larval parasitoids (Noble 1939b), while others appear to be inquiline feeding on gall tissue (Currie 1937). The short ovipositor species may feed phytophagously before killing the gall former larva at a late instar stage (Noble 1939b). *M. ?darlingi* emerged mainly from old galls in July-September with some individuals emerging in November from galls collected in July. Combined species parasitism/predation of the primary gall former from all sites was 45.5%.

All Lepidoptera emerging from *T. acaciaelongifoliae* galls were also reared from *Uromycladium* rust galls on *Acacia dealbata* in a previous study by Bashford (2002).

Adults of the weevil *Araecerus palmaris* were found sheltering in old open galls for most months of the year; often several adults were present in the same gall. Larvae were found in 36% of galls of an intermediate stage between mature soft green and old hard galls. The sex ratio was 0.86:1.0 (573 males, 667 females). A similar sex ratio (0.88:1.0, n=95) was recorded from *Uromycladium* galls on *Acacia dealbata* by Bashford (2002). Noble (1941) noted the emergence of *A. palmaris* (as *Doticus pestilens*) from galls on *A. decurrens* caused by *Trichilogaster maideni* (Froggatt).

Emergence from individual galls

There was no significant difference in the number of *T. acaciaelongifoliae* adults emerging from the different sized gall classes ($F=2.36731$, $P<0.05$, $n=100$ galls for each size class). The same applied to the proportions of emerging parasitoids (Table 2). Smaller galls tended to have higher levels of parasitism but this was not statistically significant. Larger galls did not necessarily produce a greater number of gall formers than smaller galls. However the number of external lobes on a gall determined the number of chambers each formed by a *T. acaciaelongifoliae* larva. The number of lobes on 67 large green galls greater than 30 mm diameter were counted along with the number of primary exit holes formed by *T. acaciaelongifoliae* and their relationship shown in Table 3.

Table 2. Proportion of known *T. acaciaelongifoliae* parasitoids emerging from galls of three size classes. Ten galls in each gall diameter class from each site.

Site	Galls <20 mm diameter		Galls 20-30 mm diameter		Galls >30 mm diameter	
	Parasitoids	%	Parasitoids	%	Parasitoids	%
Bell Bay	29	54	26	34	17	41
Lauriston	23	61	31	13	24	21
Blackmans Bay	22	29	39	15	12	13
Total	74	48	96	21	53	25

Table 3. Relationship between the number of gall lobes and emerging *T. acaciaelongifoliae* adults.

	Number of lobes per gall				
	1	2	3	4	5
Number of galls	16	22	22	6	1
Number of <i>T. acaciaelongifoliae</i>	24	47	61	24	4
Average per gall lobe	1.5	1.07	0.92	1	0.8

Impact of galling on plants

Galls first appeared on *A. sophorae* plants at Bell Bay in early July with galls 1-2 mm in diameter at inflorescence sites. Green galls 5 mm in diameter were infesting all lower branches of shrubs 2-3 m in height a month later (Fig 2a). In early January maximum gall development was achieved; their average weight and volume are recorded in Table 4. By early March many galls were turning brown (Fig. 2b) and starting to break down following the completion of emergence of the primary gall former and associated insects. A small proportion of galls (<3%) persist as green, fleshy, small galls until June but they seldom had exit holes. This may be a result of natural mortality of the gall former at an early stage of development.

Table 4. Average weight and volume of *T. acaciaelongifoliae* galls within each diameter class. Figures in *italics* indicate percentage of galls in each diameter class at each site. No significant difference was observed between diameter classes and sites ($F=1.06008$, $P=<0.5$, $n=90$).

Site	Galls <20 mm diameter			Galls 20-30 mm diam.			Galls >30 mm diameter		
	Weight (g)	Volume (mm ³)	%	Weight (g)	Volume (mm ³)	%	Weight (g)	Volume (mm ³)	%
Bell Bay	3.35	2848.8	<i>18.3</i>	7.16	6182.3	<i>57.6</i>	9.17	12012.8	<i>24.1</i>
Lauriston	3.54	2848.8	<i>8.9</i>	7.33	7424.1	<i>48.6</i>	12.52	12373.8	<i>42.5</i>
Blackmans Bay	2.9	2815	<i>15.4</i>	7.13	7367.8	<i>61.8</i>	8.99	9907.2	<i>22.8</i>

On infested trees very few inflorescences made the transition to flowers and seed-pods were rare on these plants. Seed production is greatly reduced by the galling of reproductive buds. The heavy aggregations of multi-celled galls on stems prevented stem elongation and patches of dying branches were evident in February on large bushes. Young shrubs did put on shoot growth in March and April when most galls were brown. The impact on larger shrubs over 3 m high was more evident with sections of the shrubs dying. The rate of phyllode abscission increased making the shrubs thin crowned and patchy. Most plants can survive a number of years of heavy gall infestations but become unsightly with branch breakage common in the winter.

Discussion

The use of fast growing *Acacia* species for amenity plantings in coastal areas of Tasmania has been encouraged by community funding programs administered by organisations such as Landcare, Greening Australia and local councils. Considerable community work goes into the initial planting and establishment phases of these programs and it is disappointing to see some plantings in decline due to biotic effects such as galling, largely due to the choice of tree species planted. Alternative *Acacia* shrub species for planting in coastal areas are Varnish wattle (*Acacia verniciflua*), Wirilda (*Acacia retinodes*) or West Australian golden wattle (*Acacia saligna*). None of these species was galled although all were present in the plantings at Bell Bay.

Dennill *et al.* (1993) records *T. acaciaelongifoliae* as forming galls on Blackwood (*Acacia melanoxylon* R. Br.) in South Africa. This species is a valuable furniture and veneer timber grown in managed native forest stands and plantations in Tasmania. In South Africa, 10% of Blackwood trees surveyed carried galls although the size and number of galls per branch were much reduced compared to other *Acacia* species examined. In Tasmania, galling of Blackwood has not been observed. The Blackwood plantation estate in Tasmania is routinely monitored by Forest Health officers for pests and diseases. Blackwoods at the Bell Bay study site were not infested. It would seem unlikely that galls caused by *T. acaciaelongifoliae* will be a threat to the expanding Blackwood plantation estate in Tasmania.

In South Africa, *T. acaciaelongifoliae* has been introduced as a gall-forming biological control agent of *Acacia longifolia* (Dennill 1987). Several native parasitic species have been found to be associated with it, causing up to 21.3% mortality (average 14.5% in four sites). In Tasmania, mortality levels averaged 45.5% but ranged from 12-61% with some differences observed in different gall size classes (Table 2). The impact of host mortality on gall formation and subsequent branch dieback appears minimal given the fecundity of the female gall former who can lay up to 400 eggs in the flower and vegetative buds of the host plant (Manongi and Hoffmann 1995). In Tasmania it is clear that parasitism rates have little impact on the number of galls developing and subsequent impact on tree viability.



Fig. 2. Impact of *Trichilogaster acaciaelongifoliae* galling on *Acacia sophorae* in Tasmania: (a) new and old galls on growing shoot; (b) heavy gall infestation on mature bush; (c) early stages of branch dieback on heavily galled bush.

Acknowledgements

My thanks to Comalco Aluminium Limited for allowing access to the Lauriston Reserve and the Fire Rehabilitation Project Area at Bell Bay. My thanks also to ANIC curators John LaSalle and John Lawrence for identification of the Hymenoptera and Coleoptera respectively. Two reviewers gave helpful advice with the manuscript.

References

- BASHFORD, R. 2002. The insect fauna inhabiting *Uromycladium* (Uredinales) rust galls on silver wattle (*Acacia dealbata*) in Tasmania. *Australian Entomologist* 29(3): 81-95.
- BOUCHER, C. and STIRTON, C.H., 1978. Long-leaved wattle *Acacia longifolia* (Andr.) Willd. Pp 44-47, in: C.H. Stirton (Ed.), *Plant invaders, beautiful but dangerous*. ABC Press, Cape Town.
- CURRIE, G.A. 1937. Galls on eucalyptus trees, a new type of association between flies and nematodes. *Proceedings of the Linnaean Society of New South Wales* 62: 147-175.
- DENNILL, G.B. 1985. The effect of the gall wasp *Trichilogaster acaciaelongifoliae* (Hymenoptera: Pteromalidae) on reproductive potential and vegetative growth of the weed *Acacia longifolia*. *Agriculture, Ecosystems and Environment* 14: 53-61.
- DENNILL, G.B. 1987. Establishment of the gall wasp *Trichilogaster acaciaelongifoliae* (Pteromalidae) for the biological control of the weed *Acacia longifolia* in South Africa. *Agriculture, Ecosystems and Environment* 19: 155-168.
- DENNILL, G.B., DONNELLY, D. and CHOWN, S.L. 1993. Expansion of the host-plant range of a biocontrol agent *Trichilogaster acaciaelongifoliae* (Pteromalidae) released against the weed *Acacia longifolia* in South Africa. *Agriculture, Ecosystems and Environment* 43: 1-10.
- GOOLSBY, J.A., BURWELL, C.J., MAKINSON, J. and DRIVER, F. 2001. Investigation of the biology of Hymenoptera associated with *Fergusonina* sp. (Diptera: Fergusoninidae), a gall fly of *Melaleuca quinquenervia*, integrating molecular techniques. *Journal of Hymenoptera Research* 10(2): 163-180.
- MANONGI, F.S. and HOFFMANN, J.H. 1995. The incidence of parasitism in *Trichilogaster acaciaelongifoliae* (Froggatt) (Hymenoptera: Pteromalidae), a gall-forming biological control agent of *Acacia longifolia* (Andr.) Willd. (Fabaceae) in South Africa. *African Entomology* 3(2): 147-151.
- NOBLE, N.S. 1938. *Tepperella trilineata* Cam., a wasp causing galling of the flower buds of *Acacia decurrens*. *Proceedings of the Linnaean Society of New South Wales* 63: 389-411.
- NOBLE, N.S. 1939a. A new species of chalcid (genus *Eurytoma*) associated with *Tepperella trilineata* Cam., a wasp causing galling of the flower buds of *Acacia decurrens*. *Proceedings of the Linnaean Society of New South Wales* 64: 223-241.
- NOBLE, N.S. 1939b. A new species of *Megastigmus* parasitic on *Tepperella trilineata* Cam., a wasp causing galling of the flower buds of *Acacia decurrens*. *Proceedings of the Linnaean Society of New South Wales* 64: 266-278.
- NOBLE, N.S. 1940. *Trichilogaster acaciae-longifoliae* (Froggatt) (Hymenopt., Chalcidoidea), a wasp causing galling of the flower-buds of *Acacia longifolia* Willd., *A. floribunda* Sieber and *A. sophorae* R. Br. *Transactions of the Royal Entomological Society of London* 90: 13-38.
- NOBLE, N.S. 1941. *Trichilogaster maideni* (Froggatt) (Hymenopt., Chalcidoidea), a wasp causing galls on *Acacia implexa* Benth., and *A. maideni* F.v.M. *Proceedings of the Linnaean Society of New South Wales* 66: 178-200.